

# PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

## NOTIFICATION OF ELECTION (PCT Rule 61.2)

Date of mailing (day/month/year)  
21 June 2001 (21.06.01)

To:  
Commissioner  
US Department of Commerce  
United States Patent and Trademark  
Office, PCT  
2011 South Clark Place Room  
CP2/5C24  
Arlington, VA 22202  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

International application No.  
PCT/AU00/01160

Applicant's or agent's file reference  
50865PCT HKS

International filing date (day/month/year)  
25 September 2000 (25.09.00)

Priority date (day/month/year)  
24 September 1999 (24.09.99)

**Applicant**

JAMES, Malcolm, Barry

1. The designated Office is hereby notified of its election made:

in the demand filed with the International Preliminary Examining Authority on:

18 April 2001 (18.04.01)

in a notice effecting later election filed with the International Bureau on:

\_\_\_\_\_

2. The election  was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

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## PATENT COOPERATION TREATY

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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

REC'D 08 MAY 2001

WPO

PCT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 50865PCT HKS:HM	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. PCT/AU00/01160	International Filing Date (day/month/year) 25 September 2000	Priority Date (day/month/year) 24 September 1999
International Patent Classification (IPC) or national classification and IPC Int. Cl. 7 B29C 33/04		
Applicant RITEMP PTY LTD et al		RECEIVED MAY 23 2003 TECHNOLOGY CENTER R3700

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

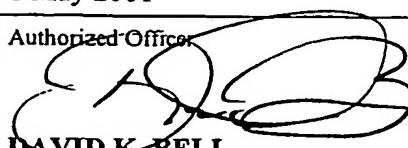
2. This REPORT consists of a total of 3 sheets, including this cover sheet.

This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheet(s).

3. This report contains indications relating to the following items:

I	<input checked="" type="checkbox"/> Basis of the report
II	<input type="checkbox"/> Priority
III	<input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	<input type="checkbox"/> Lack of unity of invention
V	<input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	<input type="checkbox"/> Certain documents cited
VII	<input type="checkbox"/> Certain defects in the international application
VIII	<input type="checkbox"/> Certain observations on the international application

Date of submission of the demand 18 April 2001	Date of completion of the report 1 May 2001
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer  DAVID K. BELL Telephone No. (02) 6283 2309

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU00/01160

**I. Basis of the report****1. With regard to the elements of the international application:\***

- the international application as originally filed.
- the description,      pages , as originally filed,  
                              pages , filed with the demand,  
                              pages , received on    with the letter of
- the claims,      pages , as originally filed,  
                              pages , as amended (together with any statement) under Article 19,  
                              pages , filed with the demand,  
                              pages , received on    with the letter of
- the drawings,      pages , as originally filed,  
                              pages , filed with the demand,  
                              pages , received on    with the letter of
- the sequence listing part of the description:  
                              pages , as originally filed  
                              pages , filed with the demand  
                              pages , received on    with the letter of

**2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.**  
These elements were available or furnished to this Authority in the following language which is:

- the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).  
 the language of publication of the international application (under Rule 48.3(b)).  
 the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

**3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, was on the basis of the sequence listing:**

- Contained in the international application in written form.  
 filed together with the international application in computer readable form.  
 Furnished subsequently to this Authority in written form.  
 Furnished subsequently to this Authority in computer readable form.  
 The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
 The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

**4.  The amendments have resulted in the cancellation of:**

- The description,      pages  
 The claims,          Nos.  
 The drawings,        sheets/fig.

**5.  This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\***

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU00/01160

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims 1 to 29	YES
	Claims	NO
Inventive step (IS)	Claims 1 to 29	YES
	Claims	NO
Industrial applicability (IA)	Claims 1 to 29	YES
	Claims	NO

**2. Citations and explanations (Rule 70.7)**

D1 = WO 9964218

D2 = Derwent Abstract Accession No 95-400128/51, Class A32, JP 07-276369.

D3 = Derwent Abstract Accession No 99-305279/26, Class A35, FR 2770897 A1

The invention as claimed in the present application is a mould for injection moulding which includes an arrangement to assist in controlling of the mould temperature including at least one chamber that is partially filled with liquid and partially filled with liquid vapour positioned such that heat is transferred from a targeted mould location to the liquid in the chamber. A condensing means is also located in the chamber to effect condensation of the liquid vapour and characterised in that the liquid in the chamber is arranged to be held at different heights in the chamber

None of the cited documents, either singly nor in obvious combination, disclose or fairly suggest the claimed invention. The claimed invention is therefore Novel, has an Inventive Step and is Industrially Applicable.

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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/AU00/01160

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int. Cl. <sup>7</sup> : B29C 33/04		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) IPC7 B29C 33/04, 41/46, 39/38, 43/52, 44/58, 45/73, 49/48, 53/84, 51/42		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Derwent WPAT: IPC7 as above + cool or condens or vap or evap or latent or pressur or head or water		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99/64218 A1 (James) 16 December 1999 Whole Document	
A	Derwent Abstract Accession No. 95-400128/51, Class A32, JP 07-276369 (TLV Co Ltd) 24 October 1995 Abstract	
A	Derwent Abstract Accession No. 99-305279/26, Class A35, FR 2770897 A1 (Oulounis K.) 14 May 1999 Abstract	
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" Later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" Document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" Document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" Document member of the same patent family
Date of the actual completion of the international search 20 October 2000		Date of mailing of the international search report <i>18 NOV 2000 - 8 NOV 2000</i>
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929		Authorized officer  DAVID K. BELL Telephone No : (02) 6283 2309

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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/AU00/01160**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
WO 9964218	AU 42512/99

**END OF ANNEX**

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(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
5 April 2001 (05.04.2001)

PCT

(10) International Publication Number  
WO 01/23158 A1(51) International Patent Classification<sup>2</sup>: B29C 33/04 (74) Agent: COLLISON & CO: 117 King William Street, Adelaide, S.A. 5000 (AU).

(21) International Application Number: PCT/AU00/01160

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.(22) International Filing Date:  
25 September 2000 (25.09.2000)

(25) Filing Language: English

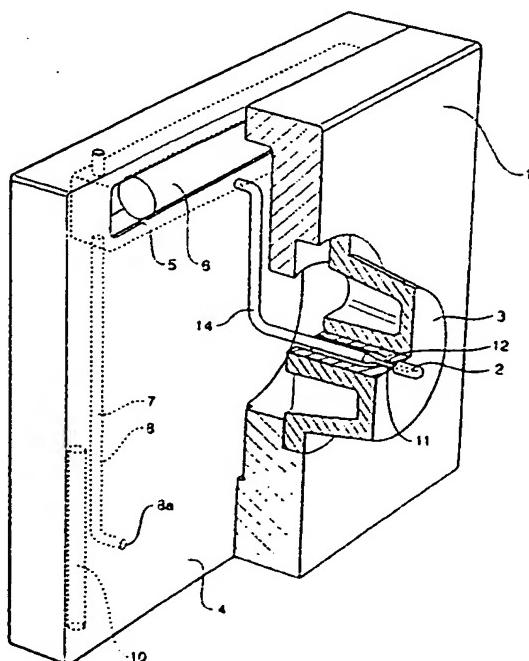
(26) Publication Language: English

(30) Priority Data:  
PQ 3077 24 September 1999 (24.09.1999) AU  
PQ 3334 11 October 1999 (11.10.1999) AU(71) Applicant (*for all designated States except US*): RITEMP  
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5063 (AU).(84) Designated States (*regional*): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG,  
CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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(75) Inventor/Applicant (*for US only*): JAMES, Malcolm,  
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(AU).**Published:**— *With international search report.**For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: IMPROVEMENTS RELATING TO COOLING OF MOLDS



(57) Abstract: An arrangement to assist in heat transfer through a mold for applications such as injection molding of plastics material including at least one closed chamber within the mold, the chamber being only partially filled with liquid and a remainder of the chamber being filled with substantially only vapour of the liquid within the chamber, at least a portion of the chamber being positioned to transmit heat from a targeted location of the mold into liquid within the chamber, and condensing means adapted by reason of heat exchange to effect condensation of vapour within the chamber, the mold being arranged in that the liquid such as water is arranged to be held in the chamber in such a way that the liquid will be distributed to reach or be held at different heights within the chamber. This is achieved in one case by the addition of a foaming agent in the liquid. In another case by having a flock attached to the inner surface of the chamber. In a further example there are separate tiers of reservoirs holding the liquid above a base level of the liquid.

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## IMPROVEMENTS RELATING TO COOLING OF MOLDS

TECHNICAL FIELD

This invention relates to cooling of molds.

Such molds can include molds of a type useful for molding of materials of a type

5 including injection molding of plastics materials.

BACKGROUND ART

There has previously been described in a previous Patent Application, an arrangement in which there is a chamber within a mold which is partially filled with a liquid and a remainder of the chamber is filled substantially only with the vapour of

10 the liquid.

There is arranged a condensing arrangement positioned above a level of liquid in the chamber in relation to a source of heat within the chamber so as to cool and condense thereby vapour formed as a result of conversion from the liquid from the source of heat.

15 This arrangement has been found to have significant advantages in keeping temperatures of portions of the mold at relatively similar temperatures and therefore those parts of the mold that are used for defining the shape of a molded article and are required to be cooled from time to time to assist in the cyclic use of the mold. Such an arrangement can keep the mold at a more uniform and even 20 temperature through its usage cycles.

One of the problems encountered has been that the head of any liquid within the chamber causes the liquid at a deepest point within a body of the liquid to be implicitly under a higher pressure and therefore the liquid at greater depth will "boil" at a higher temperature than the liquid at lesser depth. This then will result in 25 temperature differences where it would be better if these differences were not so large.

Generally it is an object of this invention to provide improvements to assist in keeping more uniform temperatures in a mold using this general concept or at the least providing the public with a useful improvement in relation to molds.

DISCLOSURE OF THE INVENTION

In one form of this invention there is proposed a mold which includes an arrangement to assist in controlling of a temperature of the mold including at least one closed chamber within the mold, the chamber being only partially filled with

- 5 liquid and a remainder of the chamber being filled with substantially only vapour of the liquid within the chamber, at least a portion of the chamber being positioned to transmit heat from a targeted location of the mold into liquid within the chamber, and condensing means by reason of heat exchange to effect condensation of vapour within the chamber, the mold being characterized in that the liquid is arranged, in  
10 use, to be distributed in the chamber in such a way that the liquid will be distributed to reach or be held at different heights within the chamber.

In preference the different heights of liquid are achieved by having at least one reservoir within the chamber with a bottom of the reservoir being above a bottom of the chamber.

- 15 In preference as an alternative the different heights are achieved by having the liquid being applied as a surface application onto an inner surface of the chamber and above a base level of liquid within the chamber.

In preference as an alternative the different heights are achieved by having a passageway with some of the liquid in the passageway where an inlet at least to  
20 the passageway is above a base upper level of liquid in the chamber.

In preference as an alternative the different heights are achieved by having the liquid selected or having an additive whereby to effect a foaming.

In one form of this invention this is achieved by having a liquid which is adapted to foam during use of the mold.

- 25 A surprising discovery is that in one of the alternative approaches by having the liquid arranged to foam as the liquid is being caused to boil results in the liquid rising as foam containing vapour of the liquid to significantly extend the liquid as a film through the chamber. This then coats the walls of the chamber with liquid.

This has a result of wetting and keeping wetted the inner surfaces of the chamber  
30 above any base level of liquid in the chamber so that implicitly the height of the

liquid being only a film adhering to the surface of the wall of the chamber will not reflect any substantial head.

In preference in this example the liquid is predominantly water and the foaming agent is a surfactant.

- 5 In trials conducted so far, the results have indicated a significant improvement in the use of water to maintain uniformity of temperature especially when the temperature is relatively low such as temperatures in the vicinity of 25 degrees Centigrade. If there were to be a significant head of water then the water at a bottom of this head is under the additional pressure of the head of water and will "boil" at a higher  
10 temperature which can be higher than that which is ideal in some cases or unacceptable in other cases.

This then also allows for the quantity of water needed in the chamber and which will normally form a base quantity of liquid to be reduced from what had previously been considered to be necessary. This then allows for the chamber to be of  
15 substantial depth without there inevitably being a head of liquid with such height that there will be caused an unacceptable boiling temperature difference of water at a top of a body of water as compared to water at a bottom of the body of water. There are other forms of achieving different heights of liquid within the chamber which will be further expounded.

- 20 In preference there is in the chamber, means to effect passage of liquid into a passage forming a part of the chamber having dimensions where surface tension of the liquid would otherwise inhibit passage of liquid thereunto.

Such an effect can be alternatively described as a situation where a vapour lock occurs.

- 25 In a further form in preference there are provided means to hold some of the liquid in a reservoir which is, therefore, in conjunction with the size and shape of the chamber and the quantity of liquid in the chamber, providing a head of liquid for use for directing a stream or other flow of the liquid through one or more conduits into places which would otherwise be inaccessible to liquid by reason of vapour lock  
30 occurring.

In a further arrangement there is provided a substantially upright conduit with a lower inlet and an upper outlet and a heat source adjacent a part of such conduit, and a means to hold any liquid lifted through the conduit by boiling of liquid effecting a percolator type effect, at a height above a normally existing upper level of liquid in  
5 the chamber.

The addition of a foaming agent has the advantage that once boiling occurs anywhere within the liquid, this foam and the water as a film implicit in the foam will readily extend in the manner of foam through the chamber and thereby carry the small amount of water that forms the film forming the foam bubbles with it.

10 The physical quantity of water that is carried on the foam can be small. Even smaller quantities of liquid however, in the chamber (which will usually be water), will be sufficient because of the technique being used.

What we can have then is a relatively small amount of water with a relatively small amount of foaming agent such as a surfactant appropriate to create foam.

15 With water being the liquid, if air is then substantially removed from the closed chamber, then boiling will only occur when the temperature of the water is raised above that which will cause a boiling of the water within the defined vapour pressure then existing within the chamber.

20 If the quantity of water is very small so that it might amount only to perhaps a small percentage of the total volume of the chamber, then with appropriate design of the chamber, the maximum height of water within the chamber can be kept very small indeed. (This then forming a base level of liquid within the chamber.)

25 It has been found in practice therefore that using the feature of a foaming agent, allows for a significant reduction in the quantity of water necessary for the purpose of holding a more uniform temperature within the mold or other mold. On the other hand, it allows for large and complex molds to be designed with shapes including a cooling chamber or chambers that would normally not provide ready access for such cooling liquid.

30 Recalling that a significant advantage of the arrangement described is that it is now easier to maintain a working temperature of all parts of the mold within a selected variation over a working cycle of operation and over different parts of the mold it

becomes possible now to design molds where cooling techniques which were previously available would not have kept the temperatures within an acceptable or at least a preferred range of temperatures. This can assist with reduced cycle times for a molding process. Furthermore, this effectively eliminates corrosion from any  
5 oxidation in the cooling chamber.

The reason corrosion will be eliminated is that a closed chamber will enable the liquid to be used only where this has had oxygen removed, at least to a substantial extent and furthermore, will not have oxygen available by reason of substantial removal of air from the space within the chamber and above the liquid level.

10 Some features of some molds may need some additional assistance in maintaining continuing liquid access for cooling purposes.

This situation is the case where the chamber has a relatively long and narrow conduit shape noting that the word "conduit" means entry into but does not necessarily mean passage to anywhere else.

15 In such a case, the surface tension of the liquid such as water in relation to the surface of the chamber may impede continuing access of liquid into the conduit shape or in other words a situation where a vapour lock effect may otherwise result.

Accordingly, there is proposed that there be means to gather liquid within the chamber but at a height higher than an entry position into the conduit shape and  
20 means to effect through an injector conduit, a supply of such liquid through the injector conduit into the conduit shape.

A further arrangement for obtaining liquid at a head above the entrance to the conduit is to have a reservoir beneath an area providing for condensing of any vapour within the chamber and then have a conduit extending from such a reservoir  
25 down into the injector conduit which has an aperture through which the liquid then will flow at a rate depending upon the head of liquid and the size of the conduit.

With such a reservoir created, which can have then any number of conduits feeding from this into injector conduits as required, such a reservoir is arranged so as to be a relatively shallow reservoir which will quickly overflow in normal operations so as to  
30 return most of the liquid to a lower reservoir.

- In an alternative arrangement, in preference there is provided a conduit which nonetheless forms a part of the closed chamber which has an inlet at a lower position within the chamber such that this inlet will be below a normal liquid level within the chamber, and an upper outlet which will direct liquid into a holding  
5 reservoir of the type previously described for feeding conduits to eventually feed injector conduits.

Further then, there is provided in an adjacent vicinity to this vertical conduit, a member to provide a source of heat targeted to any material within the vertical conduit.

- 10 The way in which the heat can be provided can vary significantly from an electrical resistance coil to a conduit connected to a hot water supply. This is a useful adjunct if additional lift of liquid is required in the circumstances of a specific mold.

However, with such an additional heat source, the effect within the conduit therefore is to effect a boiling of the liquid within the conduit and the result that liquid in the  
15 manner of a percolator is then lifted by the rising vapour from the inlet through to the outlet.

- In a further preferred arrangement, the result is achieved by having one or more dams or reservoirs which hold a limited amount of the liquid and which are arranged to collect the liquid from time to time during the "boiling" of the liquid in the chamber  
20 either by reason of rapid transition to vapour effects causing substantial ebullition and therefore implicit lifting of the liquid to appropriate heights, or by reason of condensate being directed to one or more of the dams or reservoirs.

There can be also in preference a combination of foaming agent and distributed reservoirs or dams.

- 25 Further, the reservoir or dam or dams can be arranged to overflow as they are filled with the liquid and this cascading effect can ensure that each of the reservoir and dams are kept to only a selected level and therefore head pressure and therefore maintain a reasonably small range of temperatures at which the liquid will boil within any selected reservoir or dam.

- 30 In a further development, a surface material is applied to an inner wall of the chamber above a base level of liquid in the chamber, which surface material will

assist in retention of liquid in close vicinity to the wall providing thereby a further effective height for the liquid.

In one example, at least some parts of the inner surface of the chamber are coated with a material so that surface tension implicit between the liquid and the material will

5 assist in continuing retention of the liquid against the wall.

In one example, flock in the form of a number of short strands of fibre are attached end on in close vicinity one to the other, to the surface so that liquid which reaches any such selected area thus treated, will be held to be of greater depth and therefore act as a greater reserve. This then allows for a greater tolerance in a

10 refresh rate of liquid needed to keep the surface wet. In other words, the amount of liquid available will be greater than with a smooth surface and allow therefore more tolerance in any replacement of liquid that might be being used.

The replenishment of liquid mechanism can be variously a flow from vapour being condensed above the selected area and therefore seeping or pouring over the

15 area, it can be caused by splattering or spraying from devices within the chamber, it can be subject to replenishment by rising foam, or it can be subject to replenishment simply by ebullient action of the liquid during any boiling action.

In preference then in a further form the invention then could be said to reside in a mold for molding of plastics material where there is a closed chamber using the heat

20 transfer system described to effect a transfer of heat, characterised in that at least some of the surface of the chamber has attached thereto further material or materials to assist in retention of the liquid in the adjacent vicinity of a target surface of the wall of the chamber.

In preference, the liquid is water.

25 In preference the foaming agent is a foam causing surfactant.

In preference, the materials added are a flock which is adhered by an appropriate adhesion process so that the respective particles of flock are secured end on to the surface of the chamber.

30 In preference, the thus treated surface is replenished with water from time to time during an operation of the mold by liquid being supplied from above.

In another example, replenishment is effected by foam causing film of the liquid to pass across the selected surface area wetting this thereby.

In another form of this invention this can be said to reside in the method of effecting heat transfer within a closed chamber for the purposes described where the

- 5      method includes having within the closed chamber only liquid, and the vapour of liquid within a space above the liquid within the chamber, and where a surface of the chamber selected for purpose of extracting heat therefrom is above a level of the liquid within the chamber and effecting replenishment of liquid in respect of that selected area from time to time where the selected area includes a treatment to  
10     effect retention of the liquid by use of surface tension of the liquid.

Temperatures of a mold depend to some extent upon the thickness of the metal between the heat source (e.g. a molding surface) and the selected area within the closed chamber. If there is a greater thickness, then there will be a temperature gradient that depends on the various characteristics of the metal of the mold and the

- 15     respective temperatures at each side. This can be taken advantage of in allowing some parts of a molding surface to be at a different temperature than others.

One problem with such an arrangement is that, because it relies upon an evacuation of the space within the chamber, if for any reason, there is a leak reducing or removing the evacuated state of the space, then this is a status that needs to be  
20     rapidly and reliably discernible by an operator.

I have discovered a very reliable and economic arrangement by which such status can be readily determined.

In preference there is further proposed that there be a passageway connecting with the liquid in the chamber which is closed at an upper end and which has at least a

- 25     portion which can be seen through to the extent that any liquid level within the passageway can be externally determined, and the position of the passageway including its entry and its closed upper end, is such that a level of liquid within the passageway will change from a first level where a first evacuation status within the chamber exists, to a second level where the degree of evacuation within the  
30     chamber is less than the first said evacuation status.

In effect then, it is proposed that there be a "sight glass" although its purpose is to indicate a state of evacuation and not to indicate directly at least, any level of water or other liquid within the chamber.

- 5      The advantage of the invention arises in so far that when the space within the chamber is evacuated, this will result in an equivalent drawdown of liquid level within the closed passageway.

Where the evacuation of the main chamber is compromised however, this will also then reflect in the conditions within the closed passageway and the level of water or other liquid will then appropriately rise.

- 10     There can be then any appropriate further detector of such liquid level so as to provide an automated warning or otherwise.

However, by use of the very simple and ultimately reliable use of the arrangement described, it now becomes a much improved system with the ability to monitor the status of the evacuation.

15     BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of this invention it will now be described with reference to preferred embodiments which shall now be described some with the assistance of drawings wherein:

- 20     Figure 1 is a perspective view with part cross section of one part of a plastics injection mold including an inner chamber according to a first embodiment,

Figure 2 is a cross section of a part used in a further form of the invention,

Figure 3 is a cross sectional view along the lines 4-4 in Figure 4 of a second embodiment,

Figure 4 is a cross sectional view of a second embodiment,

- 25     Figure 5 is a cross section of a third embodiment, and

Figure 6 is a cross section of a portion of a mold according to a fourth embodiment which shows a visual indicator of evacuation status of a chamber.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Now referring in detail to the drawings and in particular Figure 1 there is shown here  
5 one part or half of a plastics material injection mold 1 where this one half of the mold  
has a quite arbitrarily chosen shape with a pin 2 extending from a middle of the  
molding shape 3. A mold to be fully operational will have a further part (which is  
not shown) forming in this case a female receiving shape which further part will have  
its temperature controlled with an arrangement and method substantially the same  
10 as this first part.

In this first part, then, there is a chamber 4, which is arranged to be closed and to  
have water inserted therein and air removed.

The extent of removal of air (which in this case is achieved by applying a vacuum  
pump (not shown) to closable outlet 4a through a wall of the mold) such that  
15 substantially all of the air is removed so that only the vapour of the liquid in the  
chamber substantially fills any remaining chamber area. The liquid which is water in  
a preferred embodiment is first treated so that substantially all dissolved gases  
have been removed by, for instance, vigorously boiling the water at standard  
atmospheric pressure prior to insertion into the chamber 1. If a vacuum pump is  
20 used to evacuate air however, such dissolved air can also be removed  
subsequent to the water being introduced into the chamber 4 by use of the  
vacuum pump.

In either case the procedure to reduce dissolved gases has the added advantage  
that the water will be substantially without oxygen when in the closed area of the  
25 chamber and therefore deterioration of any metal surface by reason of oxidation  
(e.g. rust) which will ordinarily occur in existing systems will now not occur in so far  
that there is not a source of oxygen.

In this embodiment, a small quantity of household detergent is added to the water,  
the quantity being dependent on the actual detergent being used but generally is a  
30 quantity that will result in adequate foaming under the mold operating conditions. In  
the case of experiments so far, 1% by volume of household detergent (one  
example being a domestic detergent sold under the Trade Mark of Morning Fresh

by the company Cussons Pty Ltd ACN 004 164 827 in Australia) has been added to the water. Alternative foaming agents can be used.

In order to reduce temperature differentials it has been found that if a quantity of water is held with the same head height, then the temperature, in these reduced

- 5 pressure circumstances, at which the water will boil will depend on the level or more accurately the depth within any water at which boiling of that particular portion of water will take place. If a head of water created by a specific depth is above 200 mm (e.g. 300 mm) then the temperature difference is found to be of significance. Accordingly if the quantity of water is chosen to not then fill the chamber to a height  
10 greater than approximately 200 mm then this is found to provide reasonable temperature uniformity. A temperature range between 20 degrees Centigrade and 30 degrees Centigrade may in some cases be considered sufficiently uniform although in other cases a smaller range can be required and can be met by this invention and the principles espoused. The actual temperature difference required  
15 can be established and designed for.

By having the water foam, this then has the result of effectively lifting in a film, water to extend as foam through the higher parts of the chamber 4. Any such foam bubbles then will collapse randomly at higher levels with the result that water from such film will splatter onto adjacent surfaces. This then keeps these various

- 20 surfaces wet in a way which therefore allows such water to boil at a temperature established by the fact that the water is surface water without any overlying head to change its boiling temperature.

Use of foam then allows for most of the surfaces defining the chamber 4 to be kept wet by collapsing foam bubbles.

- 25 Further in Figure 1 this has a shallow trough 5 which is positioned immediately below heat exchanger 6 which is arranged to be kept cool by cooling water passing through the heat exchanger 6 and therefore effecting condensation of vapour rising in the chamber 4. The condensate is directed into the trough 5 and as it overflows the water will run down the side of the mold part 1 into a main body of  
30 liquid (water with detergent).

However, a further percolator arrangement 7 is also in place to feed water into the trough 5. This has a vertical tube 8 with an inlet 8a at a bottom of the chamber in order to draw liquid into the tube 8 and an outlet 9 by which to direct lifted water into

the shallow trough 5. A source of heat 10 is arranged alongside the tube 8 and this is provided with an electric resistance element so the quantity of heat can be easily controlled and therefore the quantity of liquid that will be lifted with this arrangement.

- 5      The value of having a higher level of liquid is that the height can be used to push  
liquid into places it otherwise might be impeded from going, for instance by reason  
of surface tension effects. In this case the example is a narrow passage 11. In this  
we have a needle injector 12 inserting liquid which is running down through tube 14  
into the passage 11 where small quantities of liquid are squirted into the narrow  
passage so as to splash and coat the inner surface of the passage with water. This  
10     water is then delivered by a higher level of pressure but on delivery the water is  
allowed to simply coat the surface. This then allows the effect to keep the  
temperature of even a small part within a mold to within an acceptable degree of  
uniformity.

Details of the needle injector are shown in greater detail in Figure 2.

- 15    Clearly, the number of tubes and the number of needle injectors can be substantial  
where however the example is showing just one.

In Figures 3 and 4 the part shown is only one part of a plastics injection mold and a matching other part or parts will have its or their own temperature distribution arrangement.

- 20    Here we have then a chamber 15 which has a plurality of cascading reservoirs 16  
and 17 which are fed by liquid returning from the condenser area 19. In this way the  
liquid is at different heights above a base level within the chamber. Each reservoir  
16 and 17 is shaped so that only a selected depth of water will stay in a respective  
reservoir and hence keep a temperature uniformity. The reservoir in each case is  
25    defined by walls 20 which are arranged to allow for overflow of the liquid when filled  
and such that the overflowing liquid will flow into the next reservoir underneath the  
first reservoir. The drawing shows an arrangement where however the water may  
to some extent follow an inward inclination of the wall 20 by reason of surface  
tension and therefore be directed as a cascade into the next reservoir beneath the  
first. As can be seen therefore, the head of liquid in any reservoir is determined by  
30    the height of water in an individual reservoir and as such this can now be  
determined by a mold designer appropriate to any application.

In the cases of the described embodiments these are used with the liquid having foaming agent so that some of the advantages of both answers can be achieved in a single mold.

- 5 In a further embodiment some of the surface of the chamber has attached thereto a flock which is adhered by an adhesive so that the respective particles of flock are secured end on to the surface of the chamber.

Use of flock enables a greater quantity of liquid to be held in the adjacent vicinity of the inner surface of the chamber in the mold.

- 10 Temperatures of a mold depend to some extent upon the thickness of the metal between the heat source (e.g. a molding surface) and the selected area within the closed chamber. If there is a greater thickness, then there will be a temperature gradient that depends on the various characteristics of the metal of the mold and the respective temperatures at each side. This can be taken advantage of in allowing some parts of a molding surface to be at a different temperature than others.

- 15 In Figure 5 there is shown an injector system 40 which has a passageway 41 with an open top 42 positioned in a chamber 43. There is a narrow mold part 44 which is arranged to be fed water through the passageway 41. The open top is at a height somewhat above the height of the part 44 so that any water in the passageway will be forced through the passageway to its lowermost outlet 45.

- 20 By having such an open top 42 with simply violent boiling of the water together with assisted lifting of the water through a foam assisted action will result in water splashing into the open top 42 and hence feeding the passageway. The mold 46 is again a part of an plastics injection mold with a condenser 47 located in a space 48 above a base level of any liquid 49.

- 25 Again then there is described an arrangement where there is distribution of liquid in a way that reduces effects of head of water and therefore causing different boiling temperatures.

- Referring to Figure 6, one of the problems with the arrangement described is that if for some reason the evacuated state of the chamber is compromised e.g. a  
30 leakage occurs, then an operator needs to know this so that the mold is not further operated until the status is corrected. The problem however is how to reliably and

cheaply determine that the evacuated status is being maintained. There is an answer that is both economic and reliable which shall now be further described.

In Figure 6 then there is shown a mold 21 for injection molding of plastics materials where there is within this, a chamber 22 which is arranged to hold water 23 and the  
5 shape of the chamber 22 is such that it will be located adjacent heat generating locations within the mold 21.

There is an opening into the chamber 22 at 24 by which air can be evacuated from a space 25 above the water in accordance with my earlier invention.

The feature of this embodiment is that there is a passageway 26 connected to a  
10 main body of the water which passageway 26 progresses from a main body of the chamber to an external viewing location where the passageway is a vertical riser and where a top of the passageway at 27 is closed.

15 The passageway 26 in this case is formed as a part of the mold except there is embedded within the external surface of the mold a transparent window 28 so that the height of liquid within the passageway will be visible to an external viewer.

With this arrangement then, the effect previously described will be observable which is that the level 30 of the liquid will be an indication of the status of evacuation within the main space of the main chamber 22. If this is changed then this will be observable to an operator who can then establish whether a leakage into the main  
20 chamber has occurred and then take appropriate action.

The height of liquid within the closed passageway will be a reflection of the evacuation status of the chamber overall.

What has now been described will allow the design of molds (or molds or other molds) with the ability easily to keep temperatures within a more uniform range than  
25 hitherto and the invention described is considered to be of groundbreaking importance in the art.

## CLAIMS

1. A mold which includes an arrangement to assist in controlling of a temperature of the mold including at least one closed chamber within the mold, the chamber being only partially filled with liquid and a remainder of the chamber being filled with substantially only vapour of the liquid within the chamber, at least a portion of the chamber being positioned to transmit heat from a targeted location of the mold into liquid within the chamber, and condensing means by reason of heat exchange to effect condensation of vapour within the chamber, the mold being characterized in that the liquid is arranged, in use, to be distributed in the chamber in such a way that the liquid will be distributed to reach or be held at different heights within the chamber.
2. A mold as in the preceding claim further characterized in that the different heights of liquid are achieved by having at least one reservoir within the chamber with a bottom of the reservoir being above a bottom of the chamber.
3. A mold as in either one of the preceding claims further characterized in that the different heights are achieved by having the liquid being applied as a surface application onto an inner surface of the chamber and above a base level of liquid within the chamber.
4. A mold as in any one of the preceding claims further characterized in that the different heights are achieved by having a passageway with some of the liquid in the passageway where an inlet at least to the passageway is above a base upper level of liquid in the chamber.
5. A mold as in any one of the preceding claims further characterized in that the different heights are achieved by having the liquid selected or having an additive whereby to effect a foaming.
6. A mold as in claim 1 further characterized in that the liquid includes a foaming agent .
7. A mold as in any one of claims 1or 2 further characterized in that the liquid is predominantly water and the foaming agent is a surfactant.

8. A mold as in any one of the preceding claims further characterised in that there is a passageway of liquid into a passage forming a part of the chamber having dimensions where surface tension of the liquid would otherwise inhibit passage of liquid thereinto.
- 5 9. A mold as in any one of the preceding claims further characterized in that there is at least one reservoir for liquid in the said chamber which is adapted to hold liquid so that a head of liquid in such a reservoir is less than the height of such liquid above other liquid in the chamber.
- 10 10. A mold as in any one of the preceding claims further characterized in that there is provided a substantially vertical conduit with a lower inlet and an upper outlet and a heat source adjacent a part of such conduit, and a means to hold any liquid lifted through the conduit by boiling of liquid effecting a percolator type effect, at a height above a normally existing upper level of liquid in the chamber.
- 15 11. A mold as in the immediately preceding claim further characterized in that there are means to gather liquid within the chamber but at a height higher than an entry position into a conduit shape and means to effect through an injector conduit, a supply of such liquid through the injector conduit into the conduit shape.
- 20 12. A mold as in the immediately preceding claim further characterized in that there is a reservoir beneath an area providing for condensing of any vapour within the chamber and a conduit extending from such a reservoir down into the injector conduit which has an aperture through which the liquid then will flow at a rate depending upon the head of liquid and the size of the conduit.
- 25 13. A mold as in any one of the preceding claims further characterized in that there is provided a conduit which forms a part of the closed chamber which has an inlet at a lower position within the chamber such that this inlet will be below a normal liquid level within the chamber, and an upper outlet which will direct liquid into a holding reservoir.
- 30 14. A mold as in the immediately preceding claim further characterized in that there is provided in an adjacent vicinity to the conduit, a means to provide a source of heat.

15. A mold as in any one of the preceding claims further characterized in that there is provided at least one dam or reservoir which holds a limited amount of the liquid and which is arranged to collect the liquid from time to time during the boiling of the liquid in the chamber either by reason of rapid transition to vapour effects

5 causing substantial ebullition and therefore implicit lifting of the liquid to appropriate heights, or by reason of condensate being directed to one or more of the dams or reservoirs.

16. A mold as in any one of the preceding claims further characterized in that the reservoir or dam or dams are arranged to overflow as they are filled with the  
10 liquid and this cascading effect can ensure that each of the reservoir and dams are kept to only a selected level and therefore head pressure and therefore maintain a reasonably small range of temperatures at which the liquid will boil within that selected reservoir or dam.

17. A mold as in any one of the preceding claims further characterized in that  
15 there is applied, a surface material to an inner wall of the chamber.

18. A mold as in the immediately preceding claim further characterized in that at least some parts of the inner surface of the chamber are coated with a material such that surface tension implicit between the liquid and the material will assist in continuing retention of the liquid against the wall.

20 19. A mold as in preceding claim 17 further characterized in that flock in the form of a number of short strands of fiber is attached end on in close vicinity one to the other, to the surface so that liquid which reaches any such selected area thus treated, will be held to be of greater depth and therefore act as a greater reserve.

25 20. A mold for molding of plastics material where there is a closed chamber using the heat transfer system described to effect a transfer of heat, characterised in that at least some of the surface of the chamber has attached thereto further material or materials to assist in retention of the liquid in the adjacent vicinity of a target surface of the wall of the chamber.

21. A mold as in the immediately preceding claim further characterized in that  
30 the liquid is water.

22. A mold as in the immediately preceding claim further characterized in that

the foaming agent is a foam causing surfactant.

23. A mold as in any one of the preceding claims further characterized in that replenishment is effected by foam causing film of the liquid to pass across the selected surface area wetting this thereby.

5 24. A mold as in any one of the preceding claims further characterized in that there is a passageway connecting with liquid in the chamber which passageway is closed at an upper end and which has at least a portion which can be seen through to the extent that any liquid level within the passageway can be externally determined and the position of the passageway including its entry and its closed  
10 upper end, is such that a level of liquid within the passageway will change from a first level where a first evacuation status within the chamber exists, to a second level where the degree of evacuation within the chamber is less than the first said evacuation status.

15 25. A method of effecting heat transfer within a closed chamber of a mold for the purposes described where the method includes having within the closed chamber only liquid, and the vapour of the liquid within a space above the liquid within the chamber, and where a surface of the chamber selected for purpose of extracting heat therefrom is above a level of the liquid within the chamber and where the liquid level is at different heights within the chamber.

20 26. A method of effecting heat transfer within a closed chamber of a mold for the purposes described where the method includes having within the closed chamber only liquid, and the vapour of the liquid within a space above the liquid within the chamber, and where a surface of the chamber selected for purpose of extracting heat therefrom is above a level of the liquid within the chamber and  
25 effecting replenishment of liquid in respect of that selected area from time to time where the selected area includes a treatment to effect retention of the liquid by use of surface tension of the liquid.

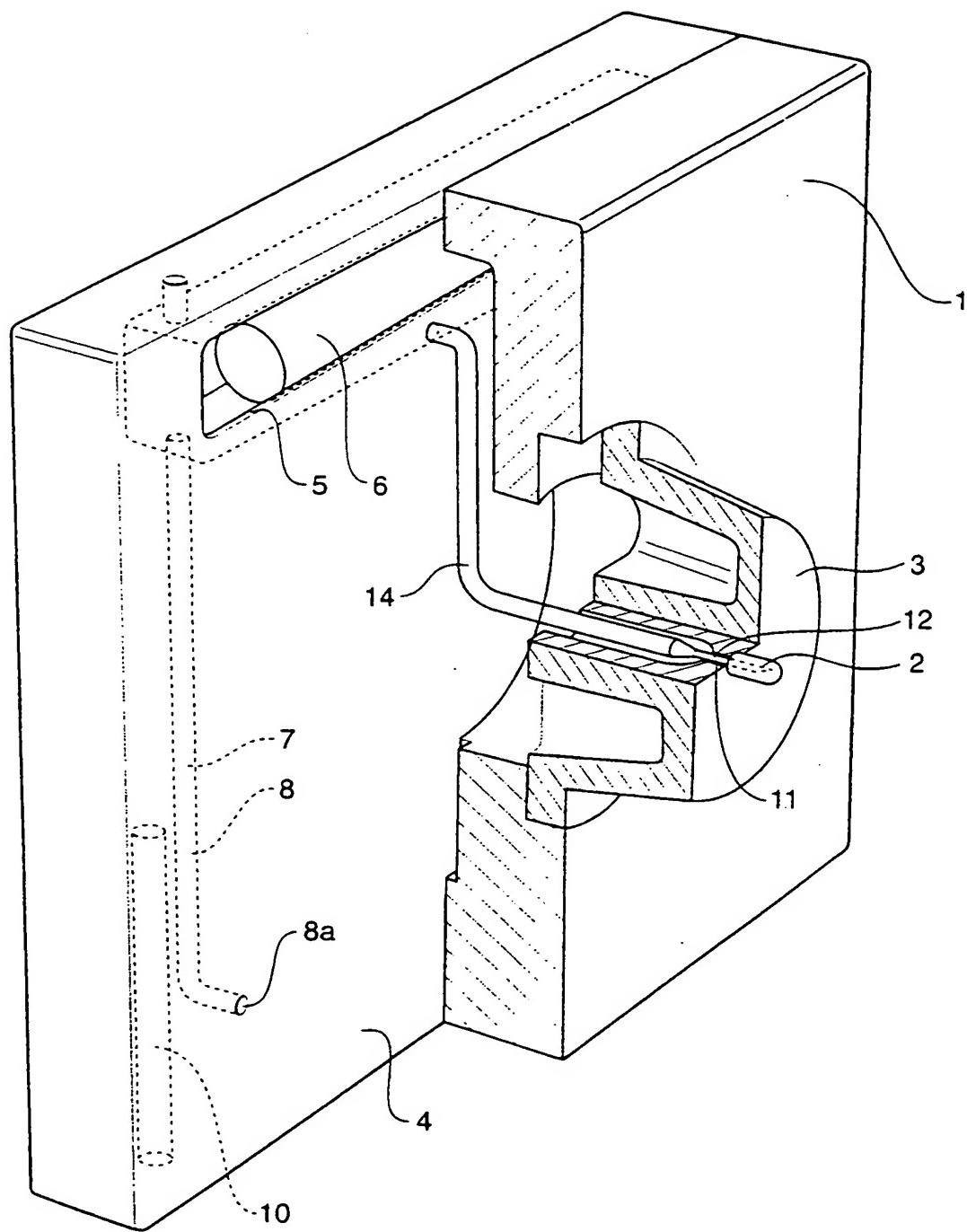
27. A method of effecting heat transfer within a closed chamber for the purposes described where the method includes having within the closed chamber  
30 only liquid, and the vapour of liquid within a space above the liquid within the chamber, and where a surface of the chamber or condenser for purpose of extracting heat therefrom is above a level of the liquid within the chamber and effecting replenishment of liquid in respect of that selected area from time to time

where the selected area includes a treatment to effect retention of the liquid by use of surface tension of the liquid.

28. A mold substantially as described in the specification with reference to and as illustrated by the accompanying drawings.
- 5 29. A method of effecting heat transfer within a mold substantially as described in the specification with reference to and as illustrated by the accompanying drawings.

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**Fig 1**

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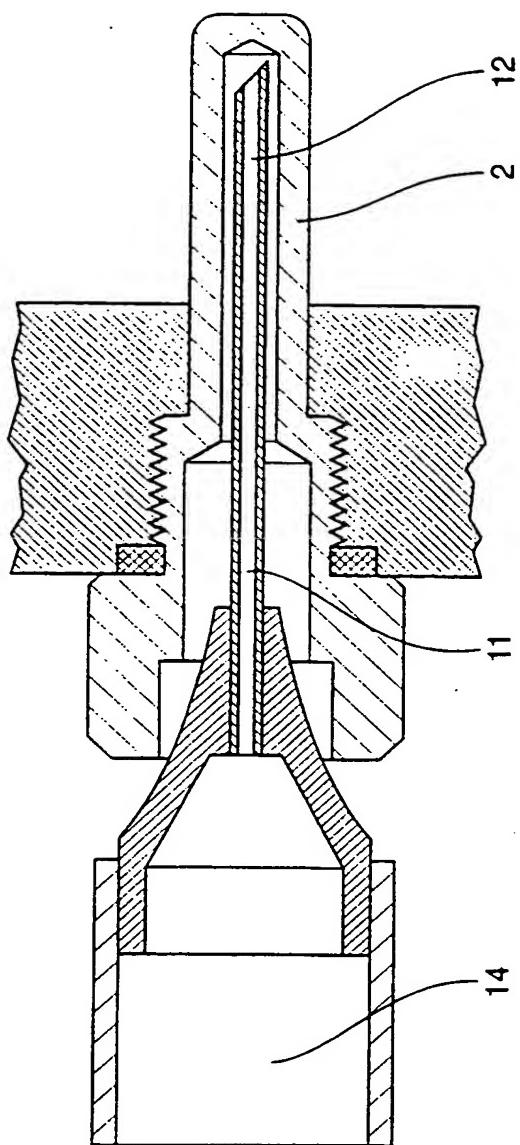


Fig 2

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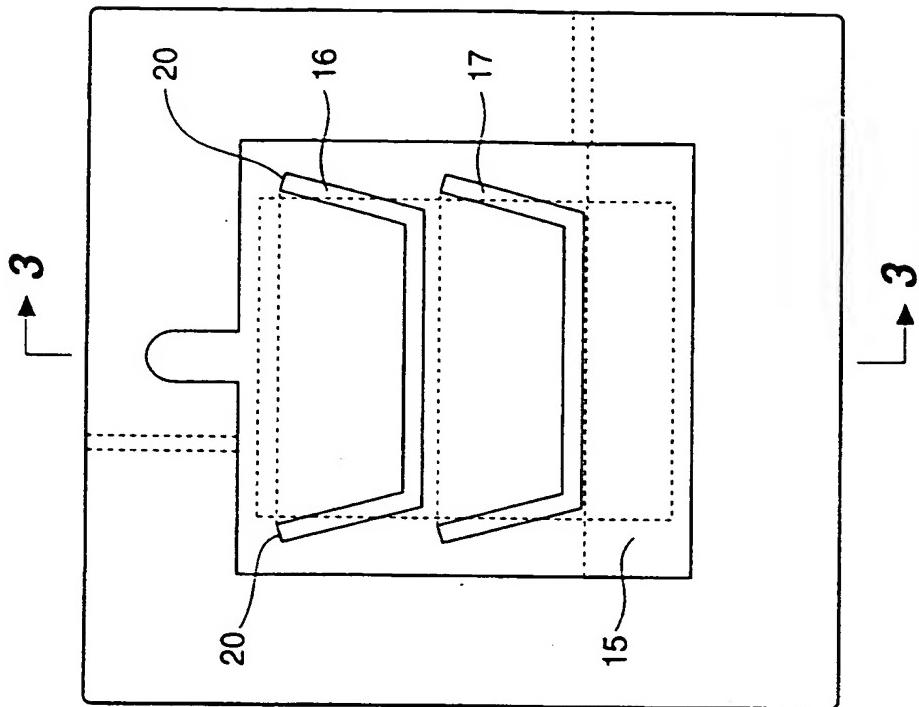


Fig 4

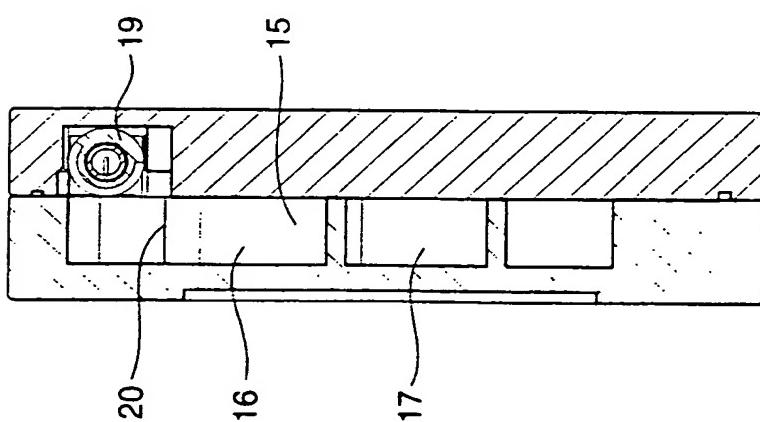


Fig 3

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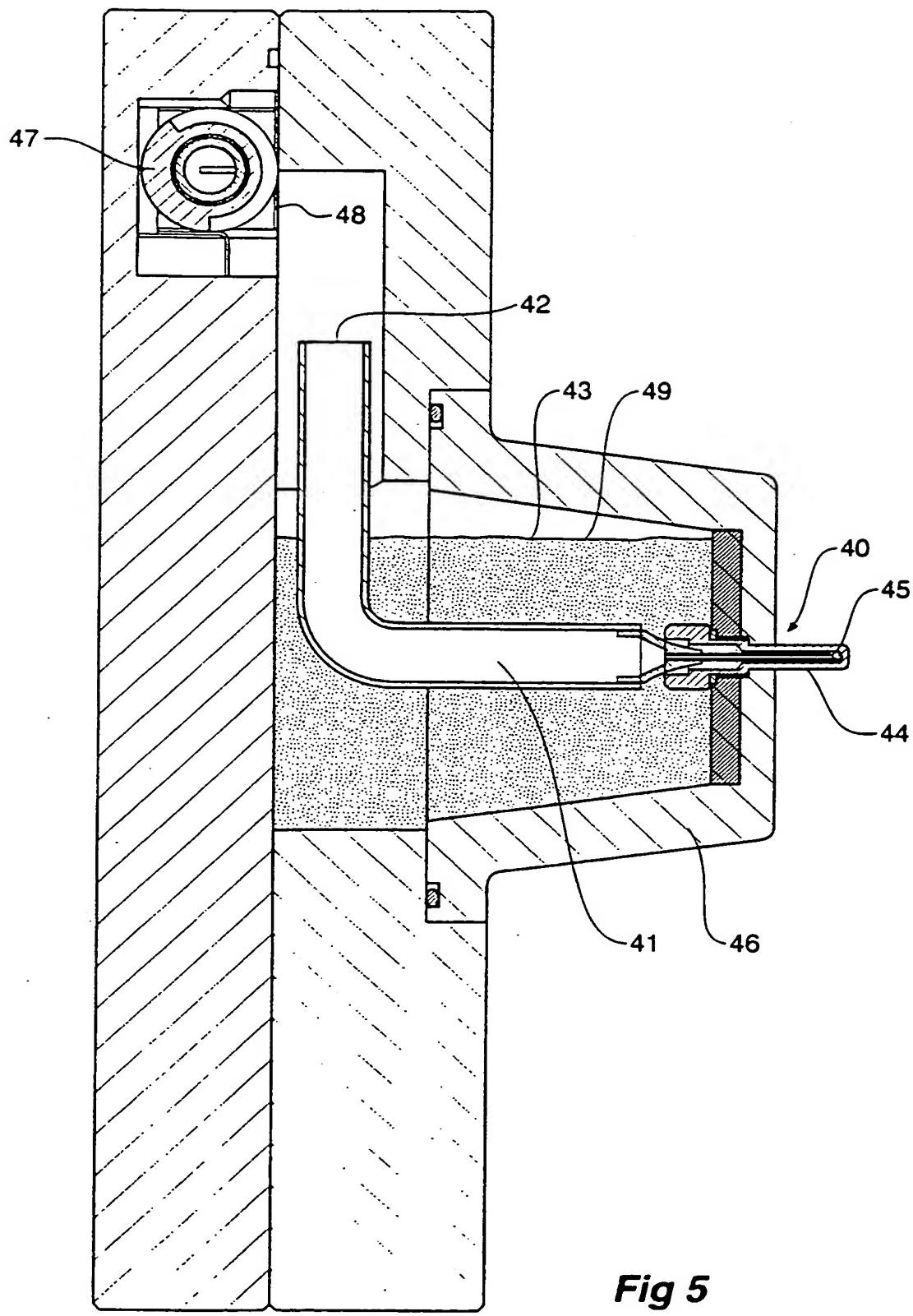


Fig 5

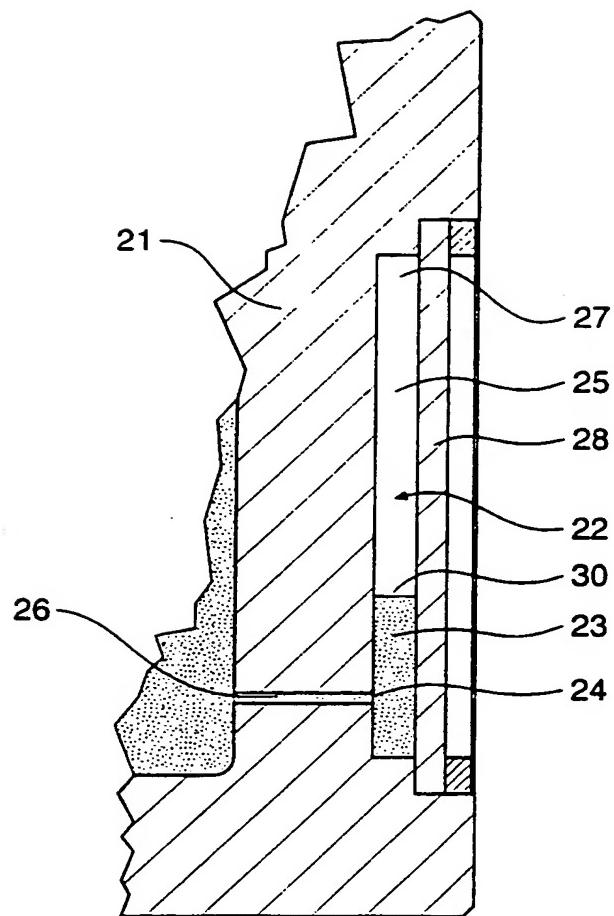
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*Fig 6*

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